Development and Post Production Characterization of value added Minor Millet Products.

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Abbreviations Used

AOAC	Association of Official Agricultural Chemists
AOCS	American Oil Chemists' Society
CVDs	Cardio Vascular Diseases
HDL	High Density Lipo proteins
ICDP-CC	Integrated Cereals Development Programme in Coarse Cereals based Cropping Systems Areas
INSIMP	Initiative for Nutritional Security through Intensive Millets Promotion
MMA	Macro Management of Agriculture
PAD	Potato dextrose agar
PDS	Public Distribution System
RADP	Rainfed Area Development Programme
RESMISA	Revalorizing Small Millets in Rainfed Regions of South Asia
RKVY	RashtriyaKrishiVikasYojana
TPCA	Total plate count agar
USDA	United States Department of Agriculture

1. Introduction

1.1 Minor Millets

The term “minor millet” is broadly used to describe various small seeded grasses that have been cultivated from ancient times. They can be classified within the generaBrachiaria,Digitaria, Echinochloa, Eleusine, Panicum, Paspalum, Pennisetum, Setaria and Sorghum (Yang et al 2012). Several species of minor millets exist. These include: browntop (*Brachiaria ramose*), barnyard (*Echinochloa crus-galli*), finger (*Eleusinecoaracana*), proso (*Panicummilaceum*), kodo (*Paspalumscrobiculatum*), little (*Panicumsumatrense*), pearl (*Pennisetumglaucum*) and foxtail (*Setariaitalica*) millets. Amongst these millet species, pearl millet is the most widely cultivated. There is archaeological evidence in Northern China (about 5800 BC), India (about 2000 BC), Japan (about 4000 BC) and West Africa (about 2400 BC) to show the domestication of millets where they eventually became staple food crops (Liu, et al 2012). It can be argued that, domestication of millets was successful due to their ability to tolerate conditions of drought (Brunken et al 1977). India being the largest producer (FAO 2012). In many of these regions, millets play an important role in the food security, where they serve as major food components in various traditional foods and beverages (Chandrasekara and Shahidi 2011). Millets have been reported to be nutritionally superior when compared to many cereals (Saleh et al 2013). They are good sources of proteins, carbohydrates, fiber and essential amino acids (Parameswaran and Sadasivam 1994). Millets are also rich in phytochemicals and micronutrients (Singh et al 2012). Lots of literature is readily available on the nutritional composition of millets (Chethan and Malleshi 2007; Subramanian and Viswanathan 2007; Chandrashekar 2010; Shobona et al 2012; Saleh et al 2013).

1.2 Health Benefits of Minor Millets:

For years, the vitamins, minerals, essential fatty acids and fiber in whole grains were believed to be responsible for their health benefits, but recent research suggests that the combinationof other bioactive substances also works to exert positiveeffects. They include resistant starch, oligosaccharides, lipids, antioxidantssuch as phenolic acids and flavonoids,hormonally active compounds including lignans and phytosterols, antinutrients such as phytic acid and tannins (Miller2001; Edge and others 2005). Millets must also be accepted as functional food nutraceuticals because they provide dietary fibers, proteins, energy, minerals, vitamins and antioxidants required for human health. Several potential health benefits such as preventing cancer and cardiovascular diseases, reducing tumor incidence, lowering blood pressure, risk of heart disease, cholesterol, rate of fat absorption, delaying gastric emptying and supplying gastrointestinal bulk were reported for millets. Recently, the U.S. Dept. of Agriculture's nutritional guidelines put grains and grain products at the base of the food guide pyramid to emphasize grains or grain product consumption as part of a normal diet for optimal health (USDA 2005).

The intake of whole grain foods is suggested to be beneficial for the prevention and management of diabetes mellitus and epidemiologically lower incidence of diabetes has been reported in millet-consuming populations (American Diabetes Association 2005; Shobana and others 2009; Kim and others 2011). Consumption of finger-millet based diets resulted in significantly lower plasma glucose levels, mean peak rise and area under curve that might have been due to the higher fiber content of finger millet than rice and wheat. The lower glycemic response of whole finger-millet-based diets may also have been due to the presence of antinutritional factors in whole finger millet flour, which are known to reduce starch digestibility

and absorption (Kumari and Sumathi 2002). Increased levels of oxidative stress markers accompanied by decreased levels of antioxidants play a vital role in delaying wound healing in diabetic rats. Finger millet feeding to the diabetic animals, for 4 weeks, controlled the glucose levels and improved the antioxidant status, which hastened the dermal wound healing process (Rajasekaran and others 2004). In another study, phenolic compounds from the millet seed coat showed strong inhibition toward α-glucosidase and pancreatic amylase (Shobana and others 2009). Furthermore, the aqueous extracts of foxtail millet grains were found to have excellent antihyperglycemic activity (Sireesha and others 2011). Some *in vivo* studies were carried out in order to investigate the effect of millet grains and their fractions on diabetes. The feeding of proso millet protein improved glycemic responses and insulin in genetically obese type-2 diabetic mice under high-fat feeding conditions (Park and others 2008). It has also been documented that finger millet helps to control blood glucose levels in diabetic patients very efficiently (Desai and others 2010). Furthermore, studies were conducted on human diabetics (male and female) living in different rural and urban locations in India and 13 diabetics were selected and asked to replace their regular wheat chapati with multigrain chapati (millet and wheat in a 30 : 70 ratio). The sugar level in high-glucose persons was lowered by continuous consumption of multigrain flour. All persons who consumed the multigrain chapati were found to have considerably decreased blood glucose levels (Pradhan and others 2010). Therefore, millet grains have the potentials to be useful in preventing diabetes and are recommended for treatment of diabetics. Therefore, millet grains and their milling fractions can be used in preparing various food products for diabetics**.**

Obesity, smoking, unhealthy diet and physical inactivity increase the risk of heart attacks and strokes. It has been demonstrated that rats fed with a diet of native and treated starch from

barnyard millet had the lowest blood glucose, serum cholesterol and triglycerides compared with rice and other minor millets (Kumari and Thayumanavan 1997). Also, the feeding of proso millet protein improved plasma levels of adiponectin, high-density lipoprotein (HDL) cholesterol in genetically obese type-2 diabetic mice under high-fat feeding conditions (Park et al. 2008). Furthermore, concentrations of serum triglycerides were significantly lower in the finger millet and proso millet groups of hyperlipidemic rats than those of the white rice and sorghum groups.

Though minor millets have so many health benefits, for consumption they need to be converted into palatable forms. This involves processing of the millet grains into various edible products.

1.3 Processing of Minor Millets

Technology used for converting the grain into edible form and thereby enhancing its quality is known as processing. Processing of cereals and millets plays a significant role during its utilization as food. Minor millets can be consumed by processing them into rice, flour, sprouting, roasted, popped, salted ready-to-eat grains, porridges and fermented products. As millet grains are hard seed coated grains, their processing starts with the task of removal of husk.

1.4 Promotion of Production and Consumption of Minor Millets

Nutritional well being is a sustainable force for health and development. Good health is a mode of maximization of human genetic potential. The nutritional status of a community has therefore been recognized as an important indicator of national development. In other words, malnutrition is a hindrance in national development and hence assumes the status of national problem. For solving the problem of deep-rooted food insecurity and malnutrition, dietary quality should be taken into consideration. Diversification of food production must be encouraged both at national and household level with increasing yields. Growing of traditional

millet crops suitable for the area is one of the possible potential successful approaches for improving household food security (Singh and Raghuvanshi 2012).

The main barriers which have limited the production and consumption of minor millets:

(1) Lower or near absence of production support when compared to the support enjoyed by other crops.

(2) Lack of reach of improved methods of production and technologies.

(3) Lack of appropriate post-harvest processing technologies for small millets except finger millet.

(4) Competition from other market friendly remunerative crops.

(5) Changes in preference patterns in consumption moving away from them, mainly due to inclusion of only rice and wheat into the Public Distribution System (PDS).

(6) Lack of public procurement and marketing support.

(7) Absence of public or private funded promotion of millets as a nutritious food category and

(8) Strong industrial demand and consequent attractive farm gate prices crowding out consumption in the area of production (Policy Review and Suggestions for Action by Revalorizing Small Millets in Rainfed Regions of South Asia (RESMISA)).

Initiatives taken for promotion of minor millets:

The Food Security Act 2013 has includes millets like ragi, jowar, bajra and minor millets in the food basket under the PDS (Public Distribution System) because of their immense health benefits. A research project Revalorizing Small Millets in RESMISA aims to increase production andconsumption of nutritious small millets and associated pulse and oil seed crops in rain fedregions of India, Nepal and Sri Lanka. It focuses on overcoming existing constraints related to production, distribution and consumption of small millets and associated crops,

pursuing a multi-pronged research strategy related to conservation, productivity enhancement, value addition, post-harvest processing, promotion and policy action to raise the profile of small millets.

Government schemes, projects or programs for promotion of production and consumption of small millets:

- Initiative for Nutritional Security through Intensive Millets Promotion (INSIMP) as part of RashtriyaKrishiVikasYojana" (RKVY).
- RainfedAreaDevelopmentProgramme (RADP) as part of RashtriyaKrishiVikasYojana" (RKVY).
- Integrated Cereals Development Programme in Coarse Cereals based Cropping Systems Areas (ICDP-CC) under Macro Management of Agriculture (MMA).

2. Review of Literature

SR NO	VARIABLES			YEAR	TITLE	AUTHERS
	Health Benefits	Millet processing	Millet popularization			
1	*			2012	Amaranth, millet and buckwheat flours affect the physical properties of extruded breakfast cereals and modulates their potential glycaemic impact.	Margaret A. et,al.
2	*			2010	Dietary management of finger millet (Eleusinecoracana L. Gaerth) controls diabetes.	Pradhan A, et,al.
3	*			2011	The inhibitory effects of ethanol extracts from sorghum, foxtail millet and proso millet on α-glucosidase and a-amylase activities.	Kim JS, et,al.
4	*			2002	Effect of consumption of finger millet on hyperglycemia in non-insulin dependent diabetes mellitus (NIDDM) subjects.	Kumari PL, et,al.
5	*			2010	Millet consumption decreased serum concentration of triglyceride and C-reactive protein butmnot oxidative status in hyperlipidemic rats.	Lee, Chung, et,al.
6	*			1997	Comparative study of resistant starch from minor millets on intestinal responses, blood glucose, serum cholesterol and triglycerides in rats.	Kumari, Thayumanavan
7	*			2010	Effect of enzymatic hydrolysis on the functional properties of foxtail millet (*Setariaitalica*L.) proteins.	Kamara, et,al.
8	*			2014	Nutritional properties of minor millets: neglected cereals with potentials to combat malnutrition	
9	*			2013	Role of Millets in Nutritional Security of India	National academy of agricultural sciences new delhi
10		*		2012	Significance of coarse cereals in health and nutrition: a review	Kaur KD et,al.
11		*		2012	Influence of decortication, popping and malting on bioaccessibility of calcium, iron and zinc in finger millet.	Krishnan R, et,al.
12		*			Quality characteristics of biscuits prepared from finger millet seed coat-based composite flour.	Krishnan R, et,al.
13		*		2011	Effect of traditional fermentation process on the nutrient and antinutrient contents of pearl millet during preparation of Lohoh.	Magdi A. Osman
14		*		2012	Suitability of Oat, Millet and Sorghum in Breadmaking	Angioloni A, et,al.
15		*		2011	Protein characterization and nutrient composition of Hungarian proso millet varieties and the effect of decortications.	Bagdia A et.al
16		*		2010	Physicochemical, Microbiological and Sensory	G.B. Adebayo

					Characteristics of Kunu Prepared from Millet, Maize and Guinea Corn and Stored at Selected Temperatures	
17		*		2011	Changes in carbohydrates, proteins and lipids of finger millet after hydrothermal processing	Dharmaraj U, et,al.
18		*		2011	Optimization of process parameters for decortication of finger millet through response surface Methodology	Dharmaraj Ravi R et,al.
19		*		2007	Traditional food-processing and preparation practices to enhance the bioavailability of micronutrients in plant-based Diets	Hotz C, Gibson RS.
20		*		2005	The effects of soaking of whole, dehulled and ground millet and soybean seeds on phytate degradation andPhy/Fe and Phy/Zn molar ratios.	Lestienne I, et al.
21		*		2003	Effect of soaking and germination on nutrient and antinutrient contents of fenugreek	Hooda S, Jood S.
22			*	2010	Nutritional and Technological Advancements in the Promotion of Ethnic and Novel Foods Using the Genetic Diversity of Minor Millets in India	NB Yenagi. et al.
23			*	2015	Minor Millets as a Central Element for Sustainably Enhanced Incomes, Empowerment, and Nutrition in Rural India	Stefano Padulosi et al.

The above studies were reviewed in relation to the present study, which are related to the studies conducted on minor millets proving that these millets have various health beneficial.

3. Justification

Minor millets are resistant to drought and climate change. They require very less fertilizers and pesticides. They are more nutritious as compared to conventional wheat, rice and corn. Minor millets prevent celiac disease as they are gluten free. They Provide antioxidants and dietary fibre, consumption of which reduces the risk of developing chronic diseases such as cardiovascular disease, type 2 diabetes and cancer. Minor millets are cost effective and easy to cultivate. Despite numerous benefits production and consumption of minor millets is reduced drastically, primarily due to increased production and popularization of wheat and rice which are however nutritionally inferior to millets. The other reason is advancement in the processing technologies for rice and wheat crops.

Therefore, development of minor millet based value added processed products are desired. Also the popularization of minor millets and their processed products is very important to promote the production of minor millets and to improve the nutritional status of the population for the prevention of many life style disorders also to maintain healthy food eating habits.

The researcher aims to make a small effort in this direction by conducting a research on developing minor millet based value added processed products and observe there post production characteristics.

4. Statement of Problem

Development and Post production characterisation of Value Added Minor Millet Products.

5. Operational Definitions:

1. Product Development: Process of developing a new product or service for the market.
2. Post production characterisation: Observation made related to the quality of the food products after development of the final product.
3. Value addition: To add value is the process of changing or transforming a product from its original state to a more valuable state.
4. Minor Millets: Minor millets are a group of highly variable small-seeded grasses, widely grown around the world as cereal crops or grains for fodder and human food.

6. Objectives:

1. To develop value added products using released varieties of 1. Pearl Millet, 2. Barnyard Millet, 3. Kodo Millet.
2. Evaluating the Sensory parameters of processed products.
3. Evaluating the Cooking Quality in processed products.
4. Shelf-life and packaging quality of prepared minor millets products.

7. Methodology:

The proposed research work will be experimental based which will include the following four phases:

- PHASE I:Selection and Collection of Samples
- PHASE-II: Processing and Recipe Development
- PHASE III:
    - Evaluation of Sensory parameters of the developed products.
    - Product Quality and cooking quality Assessment
- PHASE IV: Shelf-life and packaging quality of prepared products of minor millets.

7.1 PHASE I: SELECTION AND COLLECTION OF SAMPLE

7.1.1 **Criteria for Selection of Samples:**

- Released varieties of Pear millet, Kodo Millet, and Barnyard millet will be selected for the studies.
- Varieties with superior nutritional composition will be selected.

7.1.2. Collection of Samples:

- Selected varieties will be procured from the research institutes like IARI, PGMER, etc.

7.2 PHASE II: PROCESSING AND RECIPE DEVELOPMENT:

- Four recipes of each minor millet will be developed.
- Nutritionally rich processed products and recipes of minor millets will be developed

Processed products as mentioned below will be developed:

- Ready to eat products
    - Flakes
    - Cereal bars
- Partially prepared food products
    - Flour
    - Vermicelli
    - Instant Soup mix
    - Idly/ Dosa mix/ Dhokla Mix

7.3 PHASE III:

7.3.1 EVALUATION OF SENSORY PARAMETERS OF THE DEVELOPED PRODUCTS

Quantitative Descriptive Analysis method (Stone et al.1974) will be used to assess the quality of the products. A 9-point unstructured line scale ranging between 0 (low) to 9 (high) will be used to record the assessment. Consumer analysis will also be conducted for overall quality of the product by a pool of judges using 9-point hedonic scale anchored at (1)Like Extremely,(2)Like Very Much, (3)Like Moderately, (4)Like Slightly,(5)Neither Like nor Dislike,(6)Dislike Slightly, (7)Dislike Moderately,(8)Dislike Very Much (9)Dislike Extremely.

7.3.2 PRODUCT QUALITY AND COOKING QUALITY ASSESSMENT

7.3.2.1 PRODUCT QUALITY ASSESSMENT

7.3.2.1.1 Estimation of Moisture Content:

The moisture contents in the samples will be estimated by standard AOAC (1999) method.

7.3.2.1.2 Estimation of Protein Content:

The Kjeldhal method will be employed for protein estimation of samples. Kjeldhal method involves the oxidation of organic compounds by sulphuric acid to form carbon dioxide and water and the release of nitrogen as ammonia. The ammonia is then trapped in boric acid and titrated against standard HCl to obtain the % nitrogen in the sample. (AOAC 1999)

7.3.2.1.3 Estimation of Fat Content:

The samples will be defatted for the estimation of the fat content by refluxing with petroleum ether (60 º- 80ºC) in a Soxhlet apparatus for 18 – 20 hrs.(AOAC 1999).

7.3.2.1.4 Estimation of Ash Content:

Ash is the residue remaining after sample is ignited until it is carbon free, usually at a temperature not exceeding red heat. The ash contents of flours will be determined as per standard method (AOAC 1999).

7.3.2.2 Cooking Quality Evaluation:

- Various parameters which determine the cooking quality of a product will be utilized to determine the cooking quality of Flakes, cereal bars, vermicelli, instant soup mix and Idly/ Dosa mix/ Dhokla Mix.
- Comparable study of cooking quality between prepared value added minor millet products and products available in the market.

7.4 PHASE IV:SHELF-LIFE AND PACKAGING QUALITY OF PREPARED PRODUCTS OF MINOR MILLETS

Studies will be conducted using suitable packaging materials for specific products, with periodic withdrawal of samples after every 30 days for a period of 6 months

7.4.1 Moisture Content

Moisture content of the stored products will be analyzed. (Method no. Ac 2–41 1997) (AOCS 1998)

7.4.2 Crude Fat Content:

Analysis will be carried out according to AOCS, (Method no. Ac 3-44.)

7.4.3 Free Fatty Acid (FFA) Content:

FFA will be analyzed according to AOCS method no. Ca 5a-40 (1998).

7.4.4 Peroxide Value:

Peroxide value will be analyzed according to AOCS method no. Cd 5-53(1998)

7.4.5 Microbial Analysis:

7.4.5.1 Total Count of Mesospheric Aerobic Bacteria:

Total count of mesospheric aerobic bacteria will be enumerated by pour plate method on Total plate count agar (TPCA) and incubated at 37°C for 48hrs.

7.4.5.2 Yeast and Moulds:

For yeast and mould count, dilutions will be spread plated on Potato dextrose agar (PAD) and will be incubated at 30°Cfor 4 days.

7.5 PROMOTION AND POPULARIZATION OF MINOR MILLETS AND THEIR PROCESSED PRODUCTS:

Efforts will be made to popularize the value added processed products, using following techniques.

7.5.1 Media

7.5.1.1 Print: Newspapers

7.5.1.2 Audiovisual: Radio and local TV Channels

7.5.2 Other Means of Promotion

7.5.2.1 Organizing Exhibitions

7.5.2.2 Conducting Promotional talks

7.5.2.3 Online Promotional activities

8. Delimitations:

1. Study will be conducted in Agra city as the researcher is working in DEI.
2. Only 3 minor millets will be selected for the research, namely Kodo millet, Barnyard millet and pearl millet.
3. Only flaking, popping, flour making & vermicelli making will be done under value addition.
4. Only four recipes of selected minor millets will be developed.
5. The popularization will be done only through news papers, magazines & local television channels and by organizing exhibitions.

9. Statistical Techniques:

- Percentage, mean, median, mode and Standard deviation will calculate.
- Other statistical methods will be decided according to the nature of the data obtained.

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